

PRELIMINARY DATA SUMMARY

October 1991

U.S. Army Engineer Waterways Experiment Station  
Coastal Engineering Research Center  
Field Research Facility  
Duck, North Carolina

PRELIMINARY DATA SUMMARY

CERC Field Research Facility  
Duck, North Carolina

This report provides a summary of basic oceanographic, meteorological and bottom profile data for the month. The data were obtained as part of the Measurements and Analysis work units at the U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's Field Research Facility (FRF) in Duck, North Carolina. The FRF staff collected and analyzed these data. These summaries are intended to make the data readily available to all FRF users, and comments on their content and usefulness are invited.

## CONTENTS

	<u>Page</u>
TABLE OF CONTENTS.....	1
PART I: INTRODUCTION.....	2
PART II: METEOROLOGICAL DATA.....	6
PART III: WAVE DATA.....	9
PART IV: CURRENT DATA.....	13
PART V: SUPPLEMENTAL OBSERVATIONS.....	21
PART VI: WATER LEVELS.....	23
PART VII: NEARSHORE PROFILES AND BATHYMETRY.....	26
PART VIII: SPECIAL EVENTS.....	29

### LIST OF FIGURES

<u>No.</u>		<u>Page</u>
1	FRF location map.....	3
2	Instrument locations at FRF.....	5
3	Time history of wave heights and periods.....	12
4	Water level time history .....	24
5	CRAB profiles.....	26
6	CRAB profile envelope.....	27
7	FRF bathymetry (23 Oct 91).....	28
8	FRF bathymetry (Halloween storm, 3 Nov 91) .....	31
9	Data from selected gages during Halloween storm .....	32
10	Halloween storm CRAB profiles .....	33

### LIST OF TABLES

<u>No.</u>		<u>Page</u>
1	Instrument Status/Data Availability.....	4
2	Meteorological Data.....	7
3	Wave Data.....	10
4	Current Data.....	14
5	Supplemental Observations.....	22
6	Water Levels.....	25

## PART I: INTRODUCTION

The U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's (CERC's) Field Research Facility (FRF) is located on the Outer Banks of North Carolina, near the village of Duck (Figure 1).

The FRF research program provides a means for obtaining high-quality field data, particularly during storms, in support of the U.S. Army Corps of Engineers' coastal engineering research missions. The research pier is a reinforced concrete structure supported on 0.9-m-diam steel piles spaced 12.2 m apart along the pier's length and 4.6 m apart across the width. The pier deck is 6.1 m wide and extends from behind the duneline to about the 6-m water depth contour at a height of 7.6 m above the National Geodetic Vertical Datum (NGVD). In addition, a main building contains offices, an instrument repair shop, and a data acquisition room.

One of the responsibilities of the FRF research program is the collection, analysis and dissemination of data on local oceanographic and meteorological conditions. Bottom profiles along both sides of the pier and periodic bathymetric surveys are also performed.

This summary is intended to provide basic data as soon as possible after they are obtained. Questions and/or comments concerning the data may be directed to Mr. Michael W. Leffler at (919) 261-3511.

Part II presents the meteorological data; Parts III through VI present oceanographic data; Part VII presents nearshore profiles and bathymetry; and Part VIII, if included, documents special events that occurred at the FRF during the month.

Table 1 is a list of instruments used, their operational status during the month, and the data collection status. Figure 2 identifies the location of the instruments. The water depths at the wave gages and current meters vary and may be determined from information contained in Figure 7. Other installation information is contained in Table 1.

Times given in the report, unless otherwise specified, are referenced to eastern standard time (EST).

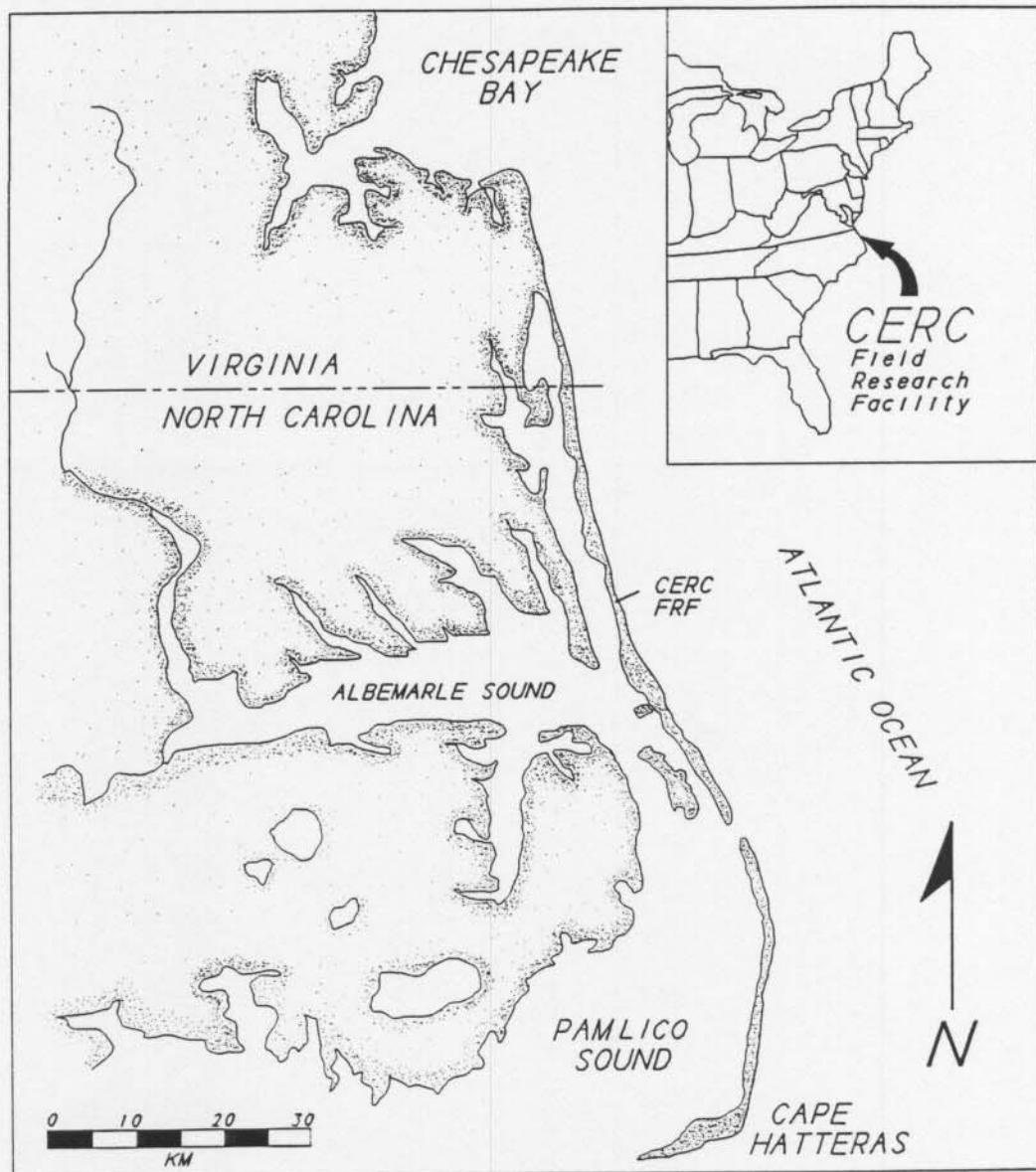


Figure 1. FRF Location Map

Table 1: Instrument Status/Data Availability

OCT 1991

Gage ID	Description/Remarks	Depth at Sensor		Day of the month																																											
				1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1													
616	Barometric Pressure		Gage Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*					
			Data Collected	*	*	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*						
			Analog Record	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*					
604	Precipitation		Gage Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*					
			Data Collected	*	*	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*					
624	Air Temperature		Gage Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*					
			Data Collected	*	*	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*					
932	Anemometer at seaward end of pier Elevation 19 m (NGVD)		Gage Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
			Data Collected	*	*	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
645	Baylor staff at station 7+80 on FRF pier	see Figure 7	Gage Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
			Data Collected	*	*	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
625	Baylor staff at station 18+60 on FRF pier	see Figure 7	Gage Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
			Data Collected	*	*	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
111	Pressure gage 309 m north of FRF pier (0.9 km offshore)	Approx. 7.8 m NGVD	Gage Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
			Data Collected	*	*	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
630	Waverider buoy 6.0 km offshore	Approx. 23 m NGVD	Gage Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
			Data Collected	*	*	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
519	Current meter 320 m north of FRF pier (0.9 km offshore)	see Figure 7	Gage Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	/	-	
			Data Collected	*	*	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	/	-			
865-1370	NOAA tide station at seaward end of FRF pier		Gage Status	-	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
			Data Collected	-	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
Supplemental Observations (daily oceanographic and meteorological observations)				Daily observation	*	*	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	

Gage Status	Daily Observation	Analog Record	Data Collected
Operational = *	Complete = *	Complete = *	All = *
Partial = /	Partial = /	Partial = /	Partial = /
Non-Operational = -	None = -	None = -	None = -

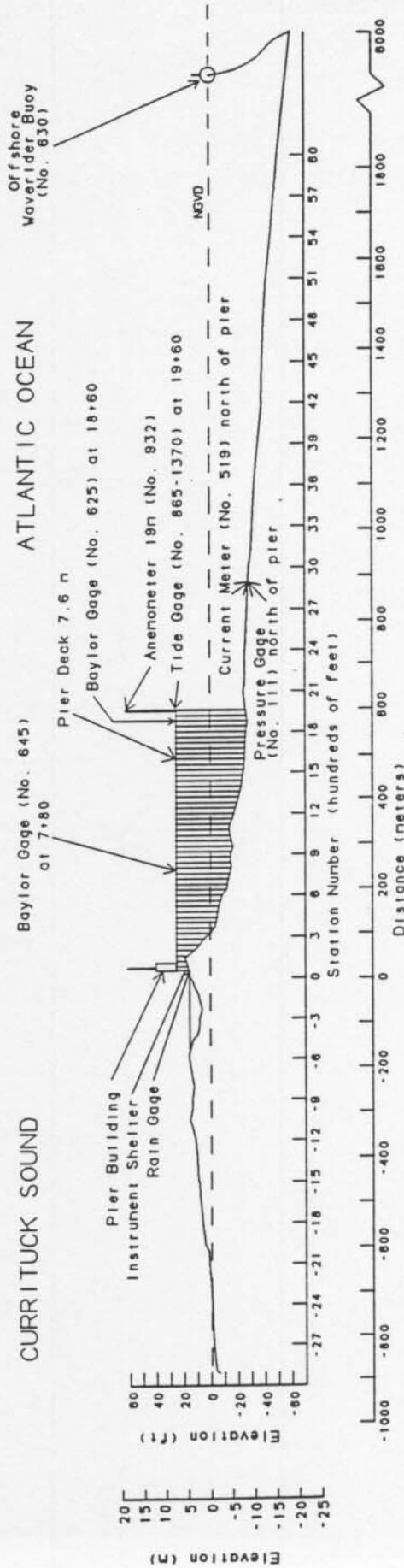
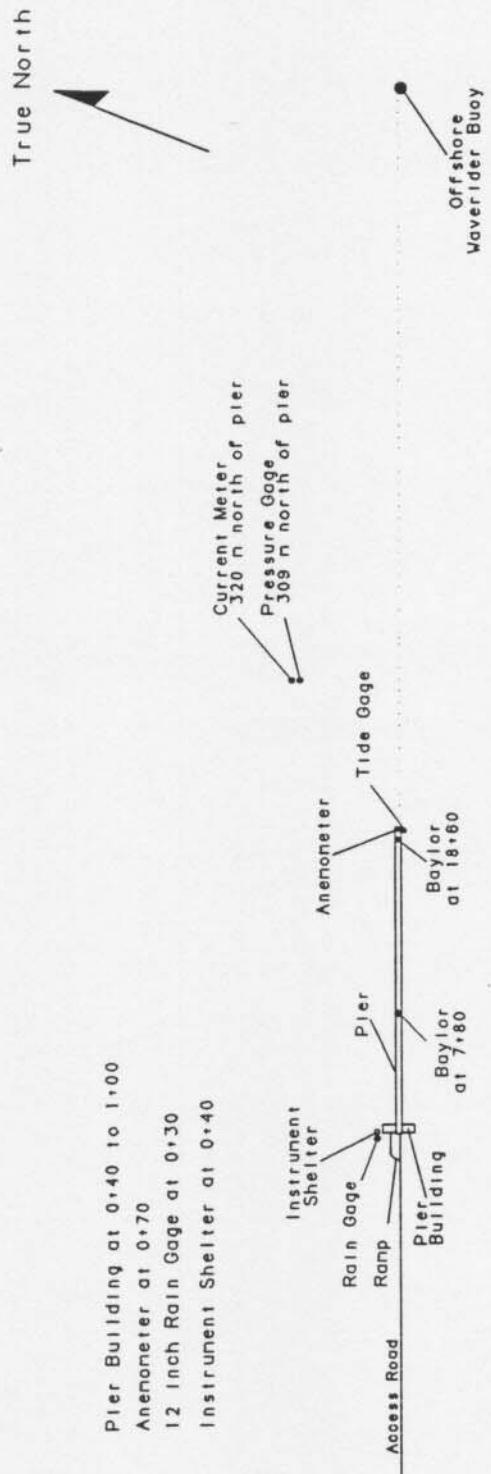


Figure 2. Instrument locations at FRF (all elevations from NGVD, all distances from FRF baseline).

## PART II: METEOROLOGICAL DATA

A variety of instruments have been installed at the FRF (Figure 2) to monitor the meteorological conditions. The data presented in Table 2 are collected and stored on magnetic tape using a Digital Equipment Corporation VAX 11/750. For each instrument identified in Table 1 as having analog outputs, chart records are obtained, a log is maintained and the records are stored for future reference.

Winds were measured at the end of the pier at an elevation of 19 m (Figure 2) using a Weather Measure Skyvane anemometer.

Monthly resultant wind speeds and directions are determined by vector averaging the data. Temperature and atmospheric pressure means are the average of the values presented for the month. Total precipitation is the sum for the month.

The following may be useful for converting the data in Table 2 to other frequently used units of measurement:

1. Millimeters (mm) to inches (in.) -  
 $mm \times .03937 = in.$
2. Millibars (mb) to inches of mercury (in. Hg) -  
 $mb \times 0.02953 = in. Hg$
3. Degrees Celsius (C) to degrees Fahrenheit (F) -  
 $(C \times 9/5) + 32 = F$
4. Meters per second (m/s) to knots (kn) -  
 $m/s \times 1.943 = kn$

Table 2: Meteorological Data

Oct 1991

Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
1	100	3	64	23.3	1023.3	0
	700	3	61	24.1	1023.0	0
	1300	4	110	26.8	1020.9	0
	1900	5	119	24.4	1019.2	0
2	100	3	134	24.9	1017.9	0
	700	5	101	24.8	1017.2	0
	1300	5	84	25.6	1016.2	0
	1900	8	62	24.9	1013.1	0
3	100	7	79	25.2	1009.4	3
	700	15	8	27.4	1008.1	16
	1300	8	350	25.1	1010.1	2
	1900	1	323	24.0	1013.5	0
4	100	2	240	24.9	1015.5	0
	700	*	Hardware Error	*	*	0
	1300	4	125	26.5	1016.9	0
	1900	5	156	24.7	1017.2	0
5	100	2	155	24.7	1016.5	0
	700	5	145	25.9	1015.9	0
	1300	8	144	29.1	1014.2	47
	1900	3	203	27.2	1012.8	0
6	100	4	214	26.8	1011.8	0
	700	4	225	26.0	1011.1	0
	1300	12	360	23.3	1010.1	0
	1900	10	331	18.7	1012.5	0
7	100	13	331	17.8	1014.8	0
	700	9	311	16.2	1018.2	0
	1300	6	318	19.1	1018.2	0
	1900	5	334	17.3	1019.2	0
8	100	5	310	17.4	1021.3	0
	700	6	19	18.4	1023.6	0
	1300	3	67	21.2	1024.7	0
	1900	3	96	19.4	1025.0	0
9	100	1	196	17.6	1025.3	0
	700	3	58	21.5	1026.0	0
	1300	4	110	24.3	1024.3	0
	1900	5	114	22.6	1023.0	0
10	100	4	134	22.3	1020.6	0
	700	4	60	23.3	1018.2	0
	1300	3	108	24.1	1014.8	0
	1900	3	108	23.2	1010.8	0
11	100	2	301	22.7	1008.1	0
	700	3	255	22.4	1006.4	0
	1300	6	244	26.2	1003.0	0
	1900	4	227	23.5	1003.0	0
12	100	5	65	21.3	1004.3	0
	700	4	230	22.0	1003.7	0
	1300	5	251	25.7	1003.3	0
	1900	7	335	21.2	1006.4	0
13	100	6	11	20.1	1008.4	0
	700	4	315	19.5	1011.1	0
	1300	6	356	21.9	1013.1	0
	1900	5	329	19.2	1015.9	0
14	100	3	338	17.4	1017.2	0
	700	3	319	19.1	1018.9	0
	1300	5	126	23.0	1017.5	0
	1900	6	133	21.9	1016.2	0
15	100	9	144	23.7	1014.2	0
	700	6	153	23.9	1011.1	0
	1300	*	Hardware Error	*	*	0
	1900	5	192	23.9	1007.7	0
16	100	2	156	23.1	1007.0	0
	700	13	359	21.9	1007.7	0
	1300	13	19	21.0	1007.7	0
	1900	15	30	20.5	1008.1	11

\* electronic problems

(Continued)

(Sheet 1 of 2)

Table 2: Meteorological Data

Oct 1991

Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
17	100	16	335	18.4	1006.0	29
	700	10	265	16.7	1008.4	16
	1300	8	278	16.0	1011.4	0
	1900	9	264	17.6	1014.5	0
18	100	7	243	18.0	1016.5	0
	700	5	289	17.6	1019.9	0
	1300	5	204	22.9	1018.9	0
	1900	4	200	19.7	1018.9	0
19	100	5	234	18.9	1017.2	0
	700	6	228	19.0	1016.9	0
	1300	6	218	25.6	1013.1	0
	1900	5	219	21.9	1013.5	0
20	100	13	6	19.8	1016.5	0
	700	11	29	18.8	1019.6	0
	1300	11	2	17.9	1020.3	0
	1900	6	34	17.6	1021.3	0
21	100	6	40	17.6	1021.6	0
	700	7	61	18.3	1021.6	0
	1300	3	52	20.8	1020.9	0
	1900	2	309	18.4	1020.6	0
22	100	3	303	17.6	1020.9	0
	700	3	324	17.7	1021.9	0
	1300	3	130	22.8	1021.6	0
	1900	4	184	20.6	1021.3	0
23	100	2	158	19.9	1022.6	0
	700	0		21.3	1024.0	0
	1300	4	108	24.6	1024.3	0
	1900	3	86	21.9	1024.7	0
24	100	3	60	22.4	1024.7	0
	700	0		21.5	1026.0	0
	1300	5	63	24.4	1024.7	0
	1900	5	70	22.7	1023.6	0
25	100	2	52	22.8	1023.0	0
	700	4	84	23.0	1023.6	0
	1300	3	75	25.2	1023.0	0
	1900	4	82	23.0	1022.6	0
26	100	4	78	22.9	1021.9	0
	700	4	25	23.1	1021.9	0
	1300	4	50	24.3	1020.9	0
	1900	7	22	23.1	1020.3	0
27	100	6	50	23.1	1019.2	0
	700	3	69	23.4	1018.6	0
	1300	8	6	22.6	1017.2	0
	1900	7	10	22.0	1016.2	0
28	100	6	359	21.8	1014.5	0
	700	8	11	22.0	1015.2	0
	1300	16	23	21.7	1016.5	0
	1900	16	34	19.4	1021.6	0
29	100	15	43	19.5	1023.3	0
	700	13	37	19.0	1025.7	0
	1300	13	27	17.9	1027.0	0
	1900	12	22	17.2	1026.7	0
30	100	11	2	17.2	1024.7	0
	700	9	327	15.3	1021.3	0
	1300	14	355	19.2	1015.9	0
	1900	3	299	16.3	1013.1	0
31	100	6	331	15.8	1010.4	0
	700	5	319	16.2	1011.1	0
	1300	11	1	19.2	1011.4	0
	1900	8	330	18.6	1013.1	0
Resultant				Mean	Mean	Total
3				21.5	1016.8	124

\* electronic problems

(Sheet 2 of 2)

### PART III: WAVE DATA

Wave data are collected from two Baylor staff gages (Gages 625 and 645), a pressure wave gage (Gage 111) and a Waverider buoy (Gage 630) as shown in Table 1 and Figure 2. The data are collected, analyzed, and stored on magnetic tape using a Digital Equipment Corporation VAX 11/750 programmed to sample the wave gages every 6 hr (more frequently during storms) beginning at 0100, 0700, 1300, and 1900 EST. The sampling rate is two times per second for four contiguous 34-min records.

Wave height  $H_{mo}$  is an energy-based statistic equal to four times the standard deviation of the sea surface elevations. Wave height reported from the pressure gage has been compensated for hydrodynamic attenuation using linear wave theory. Wave period is identified from the computation of a variance (energy) spectrum with 60 deg of freedom calculated from a 34-min record. Peak wave period  $T_p$  is defined as the period associated with the maximum energy in the spectrum. When this analysis is complete, the data are written to magnetic tape.

Table 3 presents the wave heights and periods for each wave record obtained at 6 hr intervals during the month. The monthly means and standard deviations from the means shown in Table 3 are average values computed from this data. Figure 3 is a time history of all  $H_{mo}$  and  $T_p$  values obtained for all gages.

Differences in wave periods between wave gages (Table 3 and Figure 3) may be the result of wave breaking, wave reformation, or the presence of multiple wave trains containing nearly equal energy.

Table 3: Wave Data

Oct 1991

Day	Hour	645		625		111		630	
		Baylor at 7+80	Hmo.m T.sec	Baylor at 18+60	Hmo.m T.sec	Pressure Gage	Hmo.m T.sec	Offshcr Wvrdr	Hmo.m T.sec
1	0100	1.02	6.92	0.99	6.92	0.95	6.74	1.18	7.11
	0700	0.57	6.56	0.91	7.31	0.88	7.11	1.03	6.74
	1300	0.74	6.56	0.87	7.11	0.88	7.31	0.97	6.74
	1900	0.50	8.26	0.79	6.92	0.80	6.40	0.93	8.26
2	0100	0.78	7.76	0.84	8.26	0.82	8.26	0.99	8.00
	0700	0.56	6.92	0.90	7.31	0.89	8.83	1.05	8.53
	1300	0.90	6.24	1.03	7.31	0.93	7.76	1.06	8.26
	1900	0.54	6.74	0.98	8.53	0.95	8.83	1.14	8.83
3	0100	1.06	6.92	1.23	8.53	1.22	6.24	1.42	8.00
	0700	0.98	4.34	1.87	4.74	1.80	8.83	2.02	8.00
	1300	1.43	6.24	1.95	6.56	1.89	6.56	2.12	6.40
	1900	0.89	6.09	1.32	8.53	1.24	8.53	1.44	5.95
4	0100	0.96	8.26	1.11	8.53	0.99	8.26	1.11	8.26
	0700	<b>Hardware Error</b>							
	1300	0.58	8.26	0.83	8.83	0.87	8.26	0.88	8.26
	1900	0.59	10.67	0.82	10.24	0.78	8.83	0.79	8.83
5	0100	0.28	8.53	0.67	9.14	0.69	9.48	0.76	8.53
	0700	0.54	9.14	0.65	9.48	0.64	9.48	0.77	8.53
	1300	0.42	10.67	0.79	8.53	0.78	8.83	0.83	9.14
	1900	0.65	9.14	0.75	9.14	0.70	9.48	0.78	9.48
6	0100	0.39	8.53	0.83	8.26	0.76	7.31	0.90	8.00
	0700	0.70	6.92	0.84	7.11	0.83	6.56	0.89	6.74
	1300	0.54	3.61	0.96	3.71	0.94	3.46	1.11	6.24
	1900	1.15	5.82	1.14	5.69	1.21	5.69	1.52	5.57
7	0100	0.78	5.95	1.54	6.09	1.59	6.09	1.93	5.82
	0700	1.36	7.31	1.66	6.74	1.66	6.74	1.89	7.31
	1300	0.68	6.24	1.11	6.74	1.18	7.11	1.29	6.56
	1900	0.80	6.24	0.81	6.24	0.80	6.40	1.00	5.02
8	0100	0.59	5.82	0.77	6.24	0.78	6.56	1.00	5.22
	0700	0.77	5.95	0.89	5.45	0.86	6.09	0.99	5.57
	1300	0.63	5.02	0.87	10.67	0.85	10.24	0.92	5.45
	1900	0.63	5.22	0.74	5.12	0.69	9.48	0.79	9.85
9	0100	0.55	12.80	0.72	9.14	0.68	9.48	0.73	5.69
	0700	0.51	11.13	0.71	10.67	0.67	9.14	0.67	10.67
	1300	0.50	15.06	0.70	10.24	0.73	10.24	0.64	8.83
	1900	0.70	9.85	0.79	10.24	0.74	9.85	0.75	10.24
10	0100	0.60	14.22	0.82	9.48	0.77	10.24	0.76	10.24
	0700	0.65	10.24	0.80	9.85	0.80	9.85	0.78	9.85
	1300	0.61	6.74	1.05	9.85	1.02	6.92	1.12	6.56
	1900	0.95	9.48	1.06	9.85	0.97	6.40	1.13	6.40
11	0100	0.51	9.85	0.93	9.85	0.88	9.48	0.94	6.56
	0700	0.71	9.85	0.91	9.85	0.80	8.83	0.89	9.14
	1300	0.60	9.48	0.84	9.48	0.77	9.85	0.86	8.83
	1900	0.70	9.14	0.87	9.14	0.82	9.14	0.94	9.14
12	0100	0.69	9.14	0.94	9.14	0.89	9.14	1.01	8.83
	0700	0.80	8.26	0.92	8.83	0.79	8.83	0.92	7.76
	1300	0.55	9.85	0.62	9.85	0.60	8.53	0.63	9.48
	1900	0.54	4.06	0.86	9.14	0.82	9.14	0.94	4.27
13	0100	0.81	4.49	0.83	4.66	0.84	4.66	0.89	4.49
	0700	0.47	10.67	0.70	10.67	0.69	10.24	0.75	10.67
	1300	0.66	11.64	0.71	10.67	0.68	11.13	0.73	9.85
	1900	0.40	3.94	0.80	9.14	0.79	10.24	0.90	10.67
14	0100	0.60	10.67	0.62	10.67	0.64	10.24	0.67	11.13
	0700	0.22	11.64	0.57	12.19	0.56	11.64	0.59	10.67
	1300	0.51	11.64	0.55	11.64	0.53	11.64	0.54	10.67
	1900	0.29	11.13	0.67	11.13	0.54	11.13	0.66	11.64
15	0100	0.90	4.27	0.92	4.27	0.89	4.06	1.03	4.34
	0700	0.73	6.40	1.19	6.40	1.15	6.40	1.53	6.40
	1300	0.68	8.00	1.29	7.76	1.24	8.00	1.51	7.76
16	0100	1.18	8.83	1.33	8.83	1.35	8.83	1.63	8.53
	0700	0.83	9.48	1.61	8.83	1.58	8.83	1.67	8.83
	1300	1.48	5.95	1.93	5.95	1.98	6.09	2.19	5.82
	1900	1.27	6.74	2.20	6.74	2.29	6.56	2.51	6.40

\* Electronic problems

(Continued)

Table 3: Wave Data

Oct 1991

Day	Hour	645		625		111		630	
		Baylor at 7+80	Hmo.m T.sec	Baylor at 18+60	Hmo.m T.sec	Pressure Gage	Hmo.m T.sec	Offshcr Wvrdr	Hmo.m T.sec
17	0100	1.37	7.53	2.47	7.53	2.44	7.11	2.77	6.92
	0700	1.23	8.26	1.91	8.00	1.86	8.26	2.31	7.53
	1300	1.22	8.53	1.26	9.14	1.32	8.53	1.61	9.14
	1900	0.46	9.14	0.70	9.14	0.70	9.14	0.92	8.53
18	0100	0.51	8.83	0.55	9.48	0.52	8.83	0.71	8.83
	0700	0.15	8.53	0.44	8.83	0.46	8.53	0.60	8.53
	1300	0.31	8.53	0.43	8.26	0.41	8.53	0.44	8.53
	1900	0.16	7.76	0.46	8.00	0.39	8.26	0.55	8.26
19	0100	0.24	13.47	0.38	13.47	0.38	7.31	0.49	7.53
	0700	0.11	13.47	0.37	13.47	0.39	13.47	0.49	7.53
	1300	0.13	12.80	0.42	12.19	0.40	11.64	0.48	12.80
	1900	0.26	12.80	0.45	12.80	0.44	11.64	0.59	11.64
20	0100	1.15	5.45	1.52	5.69	1.58	6.09	1.81	5.57
	0700	1.27	7.11	1.79	6.92	1.84	6.92	1.95	6.92
	1300	0.88	6.92	1.47	6.92	1.47	7.11	1.63	6.92
	1900	1.16	6.09	1.13	12.80	1.20	6.92	1.29	5.82
21	0100	0.69	12.80	1.04	12.19	1.01	13.47	1.12	13.47
	0700	0.99	14.22	1.03	14.22	0.95	13.47	1.07	12.80
	1300	0.56	12.80	0.98	13.47	0.94	13.47	0.98	12.80
	1900	0.81	13.47	0.83	13.47	0.82	12.80	0.83	14.22
22	0100	0.31	14.22	0.75	14.22	0.70	13.47	0.70	12.80
	0700	0.53	13.47	0.62	13.47	0.58	13.47	0.60	13.47
	1300	0.33	13.47	0.61	12.19	0.58	11.64	0.55	13.47
	1900	0.54	13.47	0.59	13.47	0.56	15.06	0.66	13.47
23	0100	0.35	14.22	0.66	14.22	0.63	13.47	0.61	12.80
	0700	0.51	15.06	0.63	12.80	0.61	14.22	0.60	13.47
	1300	0.41	16.00	0.66	14.22	0.60	13.47	0.54	12.19
	1900	0.56	16.00	0.63	16.00	0.55	16.00	0.55	15.06
24	0100	0.39	16.00	0.62	12.19	0.54	12.19	0.58	15.06
	0700	0.46	13.47	0.59	15.06	0.52	15.06	0.60	15.06
	1300	0.43	14.22	0.62	11.64	0.56	14.22	0.61	15.06
	1900	0.59	11.13	0.65	15.06	0.60	11.64	0.66	15.06
25	0100	0.41	15.06	0.59	15.06	0.58	11.64	0.67	14.22
	0700	0.62	10.24	0.80	9.85	0.73	9.48	0.88	6.74
	1300	0.49	8.26	0.81	8.26	0.83	8.00	0.96	7.76
	1900	0.95	8.53	1.05	8.53	1.02	9.14	1.16	8.83
26	0100	0.47	9.48	0.96	8.53	0.93	8.83	1.06	9.14
	0700	0.95	9.48	1.14	8.53	1.09	8.26	1.19	9.48
	1300	0.50	9.14	1.01	9.14	1.02	9.14	1.13	8.83
	1900	0.93	9.48	1.08	9.14	1.08	9.14	1.16	8.83
27	0100	0.56	10.24	1.12	9.14	1.13	8.83	1.16	9.14
	0700	1.10	11.64	1.54	11.13	1.52	10.67	1.50	10.24
	1300	0.97	12.80	1.63	12.19	1.65	12.19	1.82	12.80
	1900	1.03	13.47	1.88	11.64	1.80	10.24	1.83	13.47
28	0100	1.09	13.47	1.71	13.47	1.86	12.19	1.72	12.80
	0700	1.13	11.13	2.10	12.19	2.03	12.19	1.95	12.80
	1300	1.36	12.80	2.62	11.64	2.69	12.19	2.77	6.24
	1900	1.25	11.64	2.93	8.83	3.54	9.14	4.10	8.53
29	0100	1.33	11.13	3.05	9.14	3.72	10.67	3.44	9.85
	0700	1.51	15.06	2.93	12.19	3.39	12.19	3.37	12.19
	1300	1.56	15.06	2.99	13.47	3.50	14.22	3.17	13.47
	1900	1.50	14.22	2.89	14.22	3.50	13.47	2.94	14.22
30	0100	1.73	15.06	3.07	13.47	3.29	14.22	3.21	14.22
	0700	1.62	16.00	3.08	14.22	3.69	15.06	3.87	14.22
	1300	1.75	16.00	3.49	16.00	4.33	17.07	3.87	15.06
	1900	*	*	2.90	19.69	4.05	17.07	4.82	18.29
31	0100	*	*	3.29	21.33	4.45	21.33	5.41	19.69
	0700	*	*	3.19	18.29	4.31	18.29	4.43	18.29
	1300	1.86	17.07	3.51	17.07	3.80	18.29	3.26	18.29
	1900	1.62	17.07	2.85	16.00	3.12	16.00	2.87	16.00
Mean		0.77	9.95	1.22	10.14	1.27	9.96	1.37	9.71
Std dev		0.39	3.39	0.78	3.25	0.97	3.17	0.98	3.32

\* Electronic problems

(Sheet 2 of 2)

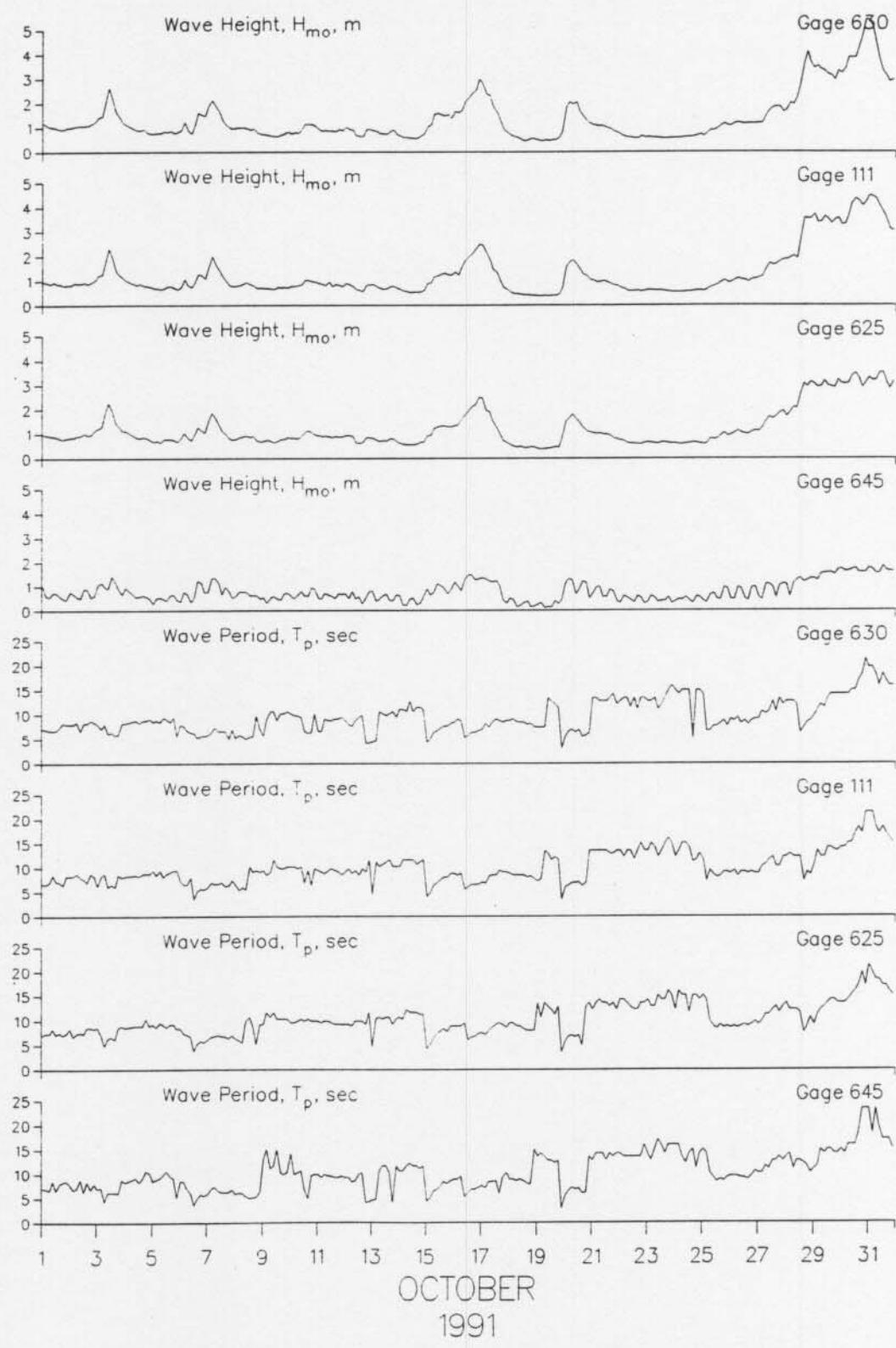


Figure 3. Time history of wave heights and periods

#### PART IV: CURRENT DATA

Current data (Table 4) are collected from a Marsh-McBirney electromagnetic biaxial current meter (Table 1 and Figure 2) and by visually observing the movement of dye on the water surface in the surf and at the seaward end of the pier, as well as 500 m updrift of the pier 12 m offshore.

Since the shoreline orientation is approximately N20W, longshore currents flow either toward 340 deg (i.e. northward) or toward 160 deg (i.e. southward). Similarly, cross-shore currents are either onshore (westward) or offshore (eastward).

All current speeds are given in centimeters per second (cm/sec). Resultant speeds and directions are determined by vector averaging the data.

Table 4: Current Data  
Oct 1991

Alongshore Cross-shore Resultant Time Day	Pier Measurements				Beach Measurements (500m Updrift)				Current Meter	
	Dye at (579 m) (surface)	Distance from Baseline (m)	Dye at Mid-Surf Zone (surface)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed	Dir	0.9 km Offshore Depth - 5.6m (NGVD) ID #519
1 0100-Along Cross Result								15	S	
								7	off	
								17	135	
1 0700-Along Cross Result	0		198	47	S		11 S	4	S	
	0			12	off	North		3	off	
	0	0		48	146			5	123	
1 1300-Along Cross Result								1	N	
								5	off	
								5	59	
1 1900-Along Cross Result								3	N	
								1	off	
								3	358	
2 0100-Along Cross Result								6	N	
								0		
								6	340	
2 0700-Along Cross Result	7	N	201	13	N		30 S	4	N	
	1	on		2	off	South		1	off	
	7	329		13	349			4	354	
2 1300-Along Cross Result								12	N	
								2	off	
								12	349	
2 1900-Along Cross Result								3	N	
								3	off	
								4	25	
3 0100-Along Cross Result								1	S	
								2	off	
								2	97	
3 0700-Along Cross Result	30	S	201	30	S		17 N	24	S	
	0	off		18	off	North		11	off	
	30	160		36	129			26	135	
3 1300-Along Cross Result								24	S	
								8	off	
								25	142	
3 1900-Along Cross Result								19	S	
								7	off	
								20	140	
4 0100-Along Cross Result								11	S	
								3	off	
								11	145	
4 0700-Along Cross Result		no observ		no observation		North		0		
4 1300-Along Cross Result								6	N	
								1	off	
								6	349	
4 1900-Along Cross Result								3	N	
								1	off	
								3	358	
5 0100-Along Cross Result								4	N	
								1	on	
								4	326	
5 0700-Along Cross Result	11	N	175	11	N		226 S	4	S	
	0			0		South		2	off	
	11	340		11	340			4	133	
5 1300-Along Cross Result								8	N	
								1	on	
								8	333	
5 1900-Along Cross Result								6	N	
								1	on	
								6	331	

KEY = All speeds in cm/sec  
 N = Northward, Shore parallel  
 S = Southward, Shore parallel  
 on = onshore off = offshore

Table 4: Current Data (Continued)  
Oct 1991

Alongshore Cross-shore Resultant Time Day	Pier Measurements				Beach Measurements (500m Updrift)				Current Meter		
	Dye at (579 m) (surface)	Speed	Dir	Dye at Mid-Surf Zone (surface)	Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed	Dir
6 0100-Along Cross Result										8	N
6 0700-Along Cross Result	0			5	N				no observation	1	on
6 1300-Along Cross Result	0	0		15	off					8	333
6 1900-Along Cross Result				15	53					8	326
7 0100-Along Cross Result										1	S
7 0700-Along Cross Result	25	S		29	S			17	N	2	off
7 1300-Along Cross Result	0			0				North		2	97
7 1900-Along Cross Result	25	160		29	160					25	142
8 0100-Along Cross Result										24	S
8 0700-Along Cross Result	10	S		22	S			30	N	8	off
8 1300-Along Cross Result	0			7	off			North		25	143
8 1900-Along Cross Result	10	160		23	143					15	S
9 0100-Along Cross Result										8	off
9 0700-Along Cross Result	0			0				4	N	9	132
9 1300-Along Cross Result	0	0		0	0			North		5	131
9 1900-Along Cross Result										10	131
10 0100-Along Cross Result										9	S
10 0700-Along Cross Result	11	N		12	N			no observation		6	off
10 1300-Along Cross Result	1	off		1	off					7	104
10 1900-Along Cross Result	11	343		12	343					1	109

KEY = All speeds in cm/sec  
 N = Northward, Shore parallel  
 S = Southward, Shore parallel  
 on = onshore off = offshore

Table 4: Current Data (Continued)  
Oct 1991

Alongshore Cross-shore Resultant Time	Pier Measurements				Beach Measurements (500m Updrift)				Current Meter		
	Dye at (579 m) (surface)	Speed	Dir	Dye at Mid-Surf Zone (surface)	Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed	Dir
Day											
11 0100-Along Cross Result										4	S
										3	off
										5	123
11 0700-Along Cross Result	8 3 9	N off 359		165	13 6 14	N off 4		South	18 S	7 1 7	N on 332
11 1300-Along Cross Result										4 2 4	N on 313
11 1900-Along Cross Result										11 3 11	N on 325
12 0100-Along Cross Result										9 6 11	S off 126
12 0700-Along Cross Result	13 6 14	N off 4		180	3 3 4	N off 28		South	44 S	5 1 5	N on 329
12 1300-Along Cross Result										5 3 6	N on 309
12 1900-Along Cross Result										4 3 5	S off 123
13 0100-Along Cross Result										14 5 15	S off 140
13 0700-Along Cross Result	29 9 30	S off 143		160	27 0 27	S 0 160		North	18 N	4 2 4	S off 133
13 1300-Along Cross Result										14 8 16	S off 130
13 1900-Along Cross Result										17 5 18	S off 144
14 0100-Along Cross Result										15 5 16	S off 142
14 0700-Along Cross Result	0 0 0			177	7 0 7	S 0 160		no observation		6 2 6	S off 142
14 1300-Along Cross Result										5 5 7	S off 115
14 1900-Along Cross Result										8 2 8	N on 326
15 0100-Along Cross Result										12 3 12	N on 326
15 0700-Along Cross Result	32 3 32	N on 334		189	51 15 53	N on 323		South	40 S	20 6 21	N on 323
15 1300-Along Cross Result											
15 1900-Along Cross Result										13 5 14	N on 319

KEY = All speeds in cm/sec  
 N = Northward, Shore parallel  
 S = Southward, Shore parallel  
 on = onshore off = offshore

Table 4: Current Data (Continued)  
Oct 1991

Alongshore Cross-shore Resultant Time	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter	
	Dye at (579 m) (surface)	Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed	Dir	
Day									
16 0100-Along Cross Result								8	N
								4	on
								9	313
16 0700-Along Cross Result	no observ	201	10	N off	26	N	12	S	
			13				4	off	
			17	32	North		13	142	
16 1300-Along Cross Result								33	S
								11	off
								35	142
16 1900-Along Cross Result								35	S
								13	off
								37	140
17 0100-Along Cross Result								53	S
								17	off
								56	142
17 0700-Along Cross Result	47 14 49	S off 143	187	47 80 92	S on 220	North	3 N	40 8 41	S off 149
								24	S
								5	off
								25	148
17 1300-Along Cross Result								13	S
								5	off
								14	139
18 0100-Along Cross Result								1	N
								0	
								1	340
18 0700-Along Cross Result	2 2 3	N off 31	189	0 0 0		South	5 S	4 1 4	N on 326
								8	
								4	on
								9	313
18 1300-Along Cross Result								4	N
								1	on
								4	326
18 1900-Along Cross Result								4	N
								1	on
								4	326
19 0100-Along Cross Result								4	N
								1	on
								4	326
19 0700-Along Cross Result	16 5 16	N off 357	213	6 1 6	N off 351	South	9 S	6 2 6	N on 322
								11	
								6	on
								13	311
19 1300-Along Cross Result								5	N
								3	on
								6	309
19 1900-Along Cross Result								28	
								7	off
								29	146
20 0100-Along Cross Result								31	S
								9	off
								32	144
20 0700-Along Cross Result	51 0 51	S off 160	168	55 50 75	S off 118	North	44 N	27 7 28	
								25	S
								7	off
								26	145
20 1300-Along Cross Result								25	S
								7	off
								26	144
20 1900-Along Cross Result									

KEY = All speeds in cm/sec  
 N = Northward, Shore parallel  
 S = Southward, Shore parallel  
 on = onshore off = offshore

Table 4: Current Data (Continued)  
Oct 1991

Day	Time	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter	
		Dye at (579 m) (surface)	Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed	Dir	0.9 km Offshore Depth -5.6m (NGVD) ID #519
21	0100-Along Cross Result							12	S	
								3	off	
								12	146	
21	0700-Along Cross Result	17 0	S 160	165	41 0	S 160	no observation		13 4	S off
		17	160		41	160			14	143
21	1300-Along Cross Result							8	S	
								4	off	
								9	133	
21	1900-Along Cross Result							9	S	
								3	off	
								9	142	
22	0100-Along Cross Result							4	S	
								0		
								4	160	
22	0700-Along Cross Result	12 4	S on	189	17 0	S 160	North	8 S	5 3	S off
		12	177		17	160			6	129
22	1300-Along Cross Result							1	S	
								1	off	
								1	115	
22	1900-Along Cross Result							1	S	
								2	on	
								2	223	
23	0100-Along Cross Result							7	N	
								3	on	
								8	317	
23	0700-Along Cross Result	8 2 9	N on 323	156	0 0 3		South	11 S	10 4 11	N on 318
					81					
23	1300-Along Cross Result							7	N	
								1	on	
								7	332	
23	1900-Along Cross Result							8	N	
								3	on	
								9	319	
24	0100-Along Cross Result							3	N	
								0		
								3	340	
24	0700-Along Cross Result	5 2 5	S on 143	165	0 0 0		South	2 S	6 2 6	N on 322
					81					
24	1300-Along Cross Result							1	N	
								0		
								1	340	
24	1900-Along Cross Result							2	N	
								1	on	
								2	313	
25	0100-Along Cross Result							3	S	
								1	off	
								3	142	
25	0700-Along Cross Result	4 5 6	S on 210	177	2 3 4	N on 290	South	11 S	1 1 1	S off 115
					81					
25	1300-Along Cross Result							8	S	
								1	off	
								8	153	
25	1900-Along Cross Result							5	S	
								1	off	
								5	149	

KEY = All speeds in cm/sec

N = Northward, Shore parallel  
S = Southward, Shore parallel  
on = onshore off = offshore

Table 4: Current Data (Continued)  
Oct 1991

Alongshore Cross-shore Resultant Time	Pier Measurements				Beach Measurements (500m Updrift)				Current Meter		
	Dye at (579 m) (surface)	Speed	Dir	Dye at Mid-Surf Zone (surface)	Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed	Dir
Day											
26 0100-Along Cross Result										8	S
										2	off
										8	146
26 0700-Along Cross Result	0	1	off	189	20	7	N off	58	S	1	N
	1	70			22	359		South		1	on
										1	295
26 1300-Along Cross Result										7	S
										2	off
										7	144
26 1900-Along Cross Result										9	S
										2	off
										9	147
27 0100-Along Cross Result										12	S
										5	off
										13	137
27 0700-Along Cross Result	29	S		189	23	N		41	S	10	S
	12	off			0					1	off
	31	138			23	340		South		10	154
27 1300-Along Cross Result										18	S
										9	off
										20	133
27 1900-Along Cross Result											
28 0100-Along Cross Result										21	S
										7	off
										22	142
28 0700-Along Cross Result	87	S		no observation				no observation			
	0										
	87	160									
28 1300-Along Cross Result										36	S
										14	off
										39	139
28 1900-Along Cross Result										62	S
										23	off
										66	140
29 0100-Along Cross Result											
29 0700-Along Cross Result	34	S		no observation				14	N		
	20	on						South			
	39	191									
29 1300-Along Cross Result										42	S
										15	off
										45	140
29 1900-Along Cross Result											
30 0100-Along Cross Result											
30 0700-Along Cross Result	76	S		no observation				no observation			
	8	off									
	77	154									
30 1300-Along Cross Result											
30 1900-Along Cross Result											

KEY = All speeds in cm/sec  
 N = Northward, Shore parallel  
 S = Southward, Shore parallel  
 on = onshore off = offshore

Table 4: Current Data (Concluded)  
Oct 1991

Alongshore Cross-shore Resultant Time	Pier Measurements				Beach Measurements (500m Updrift)				Current Meter	
	Dye at (579 m) (surface)	Speed	Dir	Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface) Location	Speed	Dir	
Day										
31 0100-Along Cross Result									8	N
31 0700-Along Cross Result				68	N				35	off
				14	on		no observation		36	57
				69	329					
31 1300-Along Cross Result	no observ			226					2	S
31 1900-Along Cross Result									10	off
									10	81

KEY = All speeds in cm/sec  
 N = Northward, Shore parallel  
 S = Southward, Shore parallel  
 on = onshore off = offshore

#### PART V: SUPPLEMENTAL OBSERVATIONS

Visual wave direction measurements (Table 5) of both the primary wave train (i.e. that having the larger wave heights) and the secondary wave train (which must be clearly distinguishable as a wave train separate from the primary waves but not surface chop or capillary waves) are taken daily at the seaward end of the pier. The direction of the primary wave train just north of the seaward end of the pier is also determined using a Raytheon Marine Pathfinder radar and measuring the alignment of the wave crests at approximately the same location as the visual measurements. The pier axis (considered perpendicular to the beach at the FRF) is orientated 70 deg east of true north; consequently, wave angles greater than 70 deg indicate that the waves were coming from the south side of the pier.

The width of the surf zone (seawardmost breaker position to shoreline) is determined from the pier deck.

Measurements of surface water temperature, density, and visibility are also taken daily at the seaward end of the pier. A jar along with a thermometer is lowered about 0.3 m into the water and allowed to remain for at least one minute. The jar is removed, the temperature read, and a hydrometer is used to determine the density. A Secchi disc is used to determine the surface visibility.

Table 5: Supplemental Observations

Oct 1991

Day	Time	Wave Approach			Radar Wave Angle deg from True N	Width of Surf Zone.m	Water Characteristics at Pier End		
		Primary	Secondary	deg from True N			Temp..C	Density g/cc	Secchi Vis..m
1	0740	20	70			146	22.3	1.0219	2.1
2	0727	130	70			146	22.8	1.0218	2.4
3	0730	30			90	183	22.0	1.0218	1.5
4	0800	70	30			122	22.2	1.0216	0.9
5	0815	125				113	22.8		3.0
6	1030	125				146	22.2		1.2
7	0745	40			50	110	20.6		1.2
8	0742	50	25		45	85	20.0		1.8
9	0740	50	130		50	73	20.8		2.1
10	0739	85	70		85	85	21.1		2.4
11	0736	130	70			98	21.1		2.4
12	0815	110				86	21.1		2.4
13	0800	35				101	20.6		2.7
14	0835	65	10			134	20.6		3.0
15	0745	100	150		55	183	20.9		3.0
16	0745	20	105		105	195	20.6		0.9
17	0826	30	140		45	177	19.0		0.9
18	0754	5				113	18.9		1.2
19	0745	140				132	18.9		1.5
20	0810	50			40	158	18.9		0.9
21	0800	35	80		35	122	18.3		1.2
22	0730	5				122	18.8		1.8
23	0920	75	140			98	18.5		2.1
24	0746	40	75			122	18.7		1.5
25	0815	120	40		60	122	20.0		1.8
26	0835	120	30		95	133	20.6		2.7
27	1015	100	5		90	169	21.1		1.5
28	0915	90			85	183	20.6		0.9
29	0830	70			85	427	17.8		0.6
30	0930	80			65	439	16.5		0.9
31	0930	60	140		65	439	17.2		0.9

## PART VI: WATER LEVELS

Since 1978, the National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service (NOS) has operated a primary tide station (No. 865-1370) at the seaward end of the FRF pier. A Leupold-Stevens digital recording float-type tide gage is used to collect instantaneous water level data every 6 minutes throughout the month.

The variation in water level during the month is shown in Figure 4 along with a list of mean and extreme values. This presentation is useful in identifying effects of both meteorological and astronomical forces on the open coast water level.

Table 6 contains the time at the center of each 12.42-hr tidal cycle and the range, high, low, and mean water levels during each tidal cycle.

## FRF Tide Heights

Oct 1991

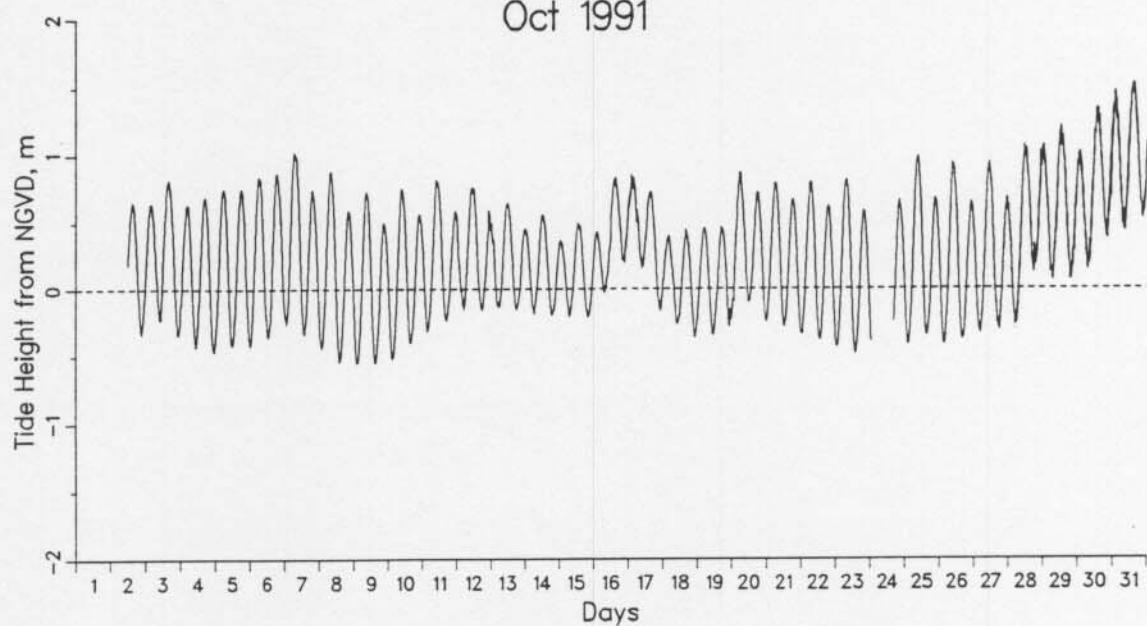


Figure 4. Water level time history

### Monthly Water Levels,m NGVD

Extreme Low = -0.55 on day 9 at 148 EST  
Extreme High = 1.53 on day 31 at 1424 EST  
Monthly Mean = 0.27  
Mean Low = -0.23  
Mean High = 0.82  
Mean Range = 1.04

Table 6: Water Levels.m NGVD

		Oct 1991			
Day	Mid-Cycle Time	Low	High	Mean	Range
1	506	—	—	—	—
1	1731	Gage Inoperative			
2	556	—	—	—	—
2	1821	-0.33	0.65	0.17	0.98
3	646	-0.23	0.77	0.28	0.99
3	1912	-0.34	0.82	0.22	1.16
4	737	-0.43	0.64	0.14	1.07
4	2002	-0.46	0.69	0.10	1.16
5	827	-0.42	0.75	0.17	1.17
5	2052	-0.42	0.76	0.19	1.18
6	918	-0.36	0.84	0.24	1.19
6	2143	-0.26	0.89	0.34	1.15
7	1008	-0.34	1.02	0.33	1.36
7	2233	-0.44	0.75	0.17	1.18
8	1058	-0.54	0.88	0.14	1.42
8	2324	-0.55	0.61	0.04	1.16
9	1149	-0.55	0.73	0.07	1.27
10	14	-0.52	0.65	0.03	1.17
10	1239	-0.40	0.75	0.15	1.15
11	104	-0.31	0.78	0.18	1.09
11	1330	-0.23	0.81	0.24	1.05
12	155	-0.16	0.75	0.26	0.90
12	1420	-0.16	0.76	0.26	0.92
13	245	-0.13	0.62	0.22	0.76
13	1510	-0.15	0.64	0.21	0.79
14	336	-0.19	0.55	0.17	0.73
14	1601	-0.19	0.55	0.14	0.75
15	426	-0.21	0.45	0.11	0.66
15	1651	-0.21	0.50	0.12	0.71
16	516	-0.02	0.74	0.26	0.77
16	1741	0.20	0.83	0.54	0.63
17	607	0.16	0.85	0.49	0.70
17	1832	-0.16	0.73	0.25	0.89
18	657	-0.26	0.40	0.07	0.66
18	1922	-0.36	0.45	0.05	0.81
19	747	-0.34	0.46	0.07	0.80
19	2013	-0.28	0.70	0.15	0.99
20	838	-0.10	0.87	0.36	0.97
20	2103	-0.25	0.72	0.25	0.96
21	928	-0.28	0.79	0.25	1.07
21	2153	-0.34	0.71	0.19	1.05
22	1019	-0.38	0.80	0.18	1.18
22	2244	-0.43	0.77	0.13	1.20
23	1109	-0.48	0.81	0.14	1.30
23	2334	Gage Inoperative			
24	1159	—	—	—	—
25	25	-0.42	0.95	0.19	1.37
25	1250	-0.34	0.98	0.25	1.33
26	115	-0.41	0.94	0.19	1.35
26	1340	-0.37	0.92	0.20	1.29
27	205	-0.33	0.91	0.22	1.23
27	1431	-0.31	0.94	0.25	1.25
28	256	-0.27	1.03	0.27	1.29
28	1521	0.12	1.07	0.60	0.95
29	346	0.06	1.16	0.60	1.09
29	1611	0.07	1.21	0.62	1.14
30	437	0.14	1.18	0.64	1.04
30	1702	0.37	1.34	0.88	0.97
31	527	0.43	1.47	0.95	1.04
31	1752	0.52	1.53	1.02	1.01

## PART VII: NEARSHORE PROFILES

A. Nearshore Profiles. In order to document profile response away from the pier, surveys of four profile lines extending 900 to 1,000 m from shore and located 489 and 581 m north and 517 and 608 m south of the FRF pier are conducted bi-weekly, after storms, and during more complete bathymetric surveys.

These profiles are obtained using the CRAB-Geodimeter surveying system; a Geodimeter 140-T self-tracking, electronic theodolite, distance meter, in combination with the Coastal Research Amphibious Buggy (CRAB), a 10.7 m high, self-powered, mobile tripod on wheels.

Figure 5 shows the last survey in September and the two surveys in October on profile line 188, located 517 m south of the pier. The nearshore bar (160 - 320 m) migrated seaward resulting in a total offshore movement of 80 m. Only minor changes are visible to the remainder of the profile.

Note that a major storm "the Halloween Storm" (see Special Events, Part VIII) began at the end of October and continued into November thus the survey data does not reflect the impact of this significant event.

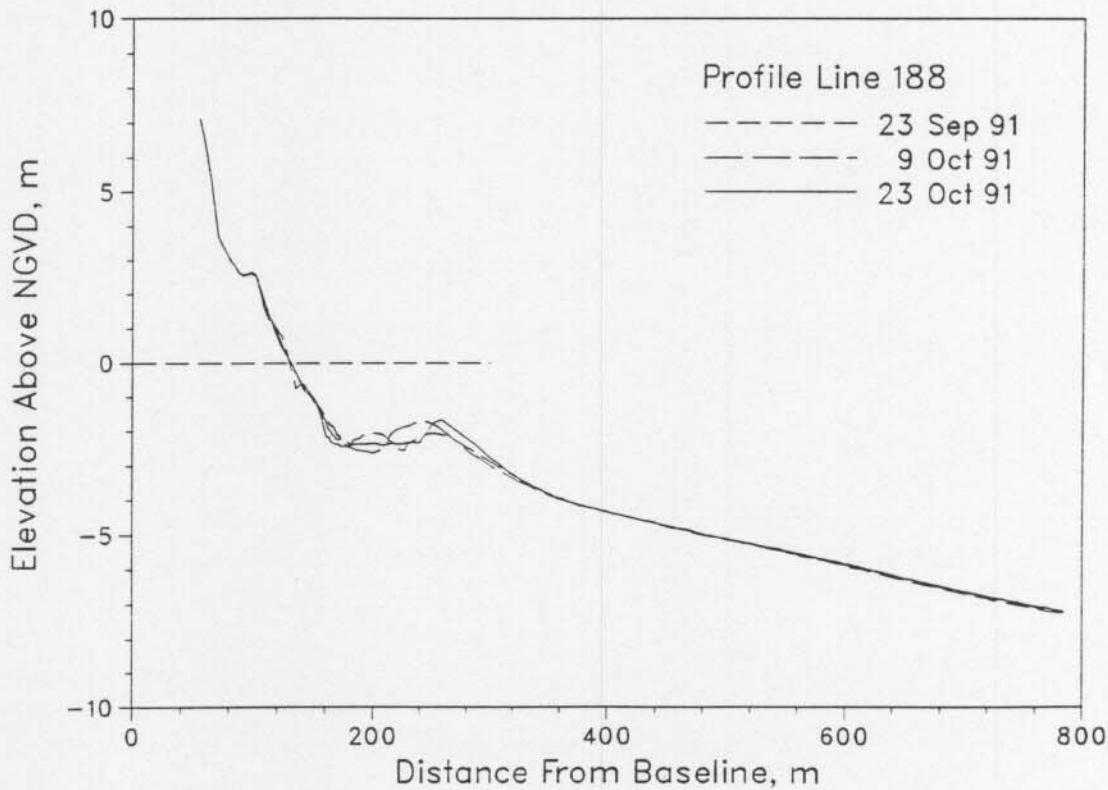


Figure 5. Monthly CRAB profiles on profile 188 - 517 m south of pier.

The profile envelope (Figure 6) reflects the maximum changes that occurred on the profile during 1991. The minor change in the nearshore (at 260 m) is a result of the seaward movement of the nearshore bar.

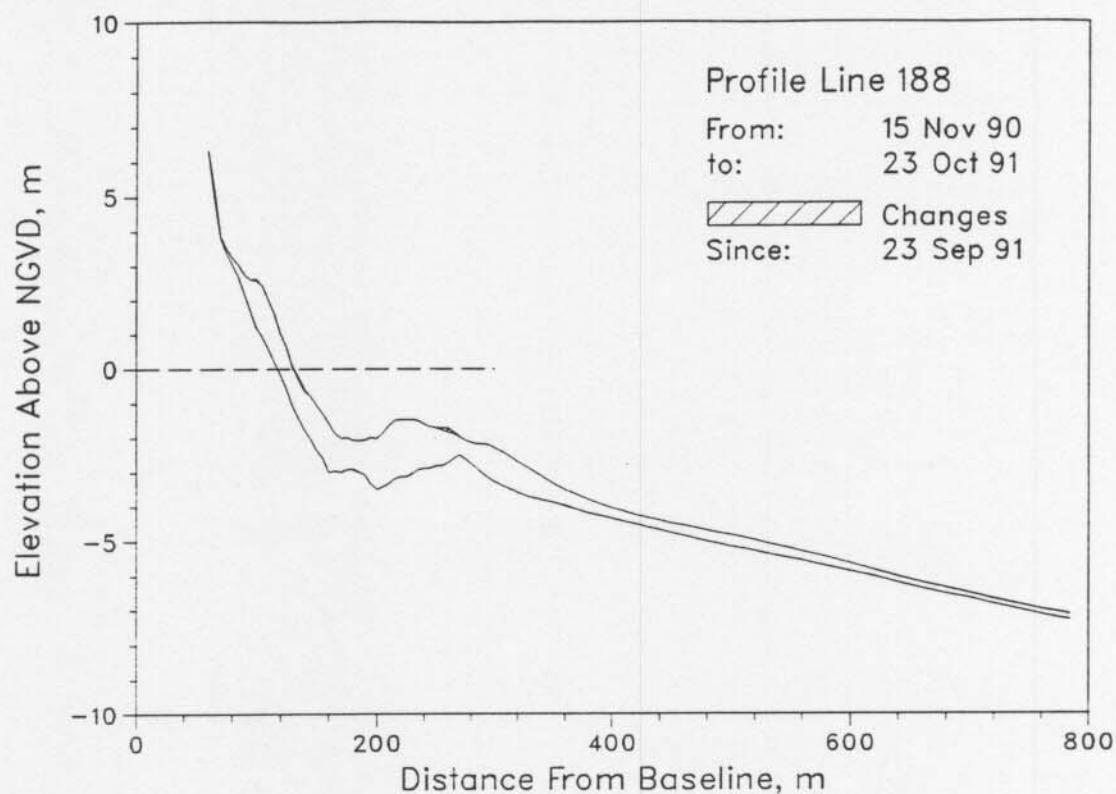


Figure 6. CRAB profile envelope - profile 188.

B. Bathymetry. Figure 7 includes a two- and three-dimensional contour map and a change plot derived from the bathymetric survey on 23 October. Wide contour lines on the change diagram represent eroded areas; thin lines indicate deposition.

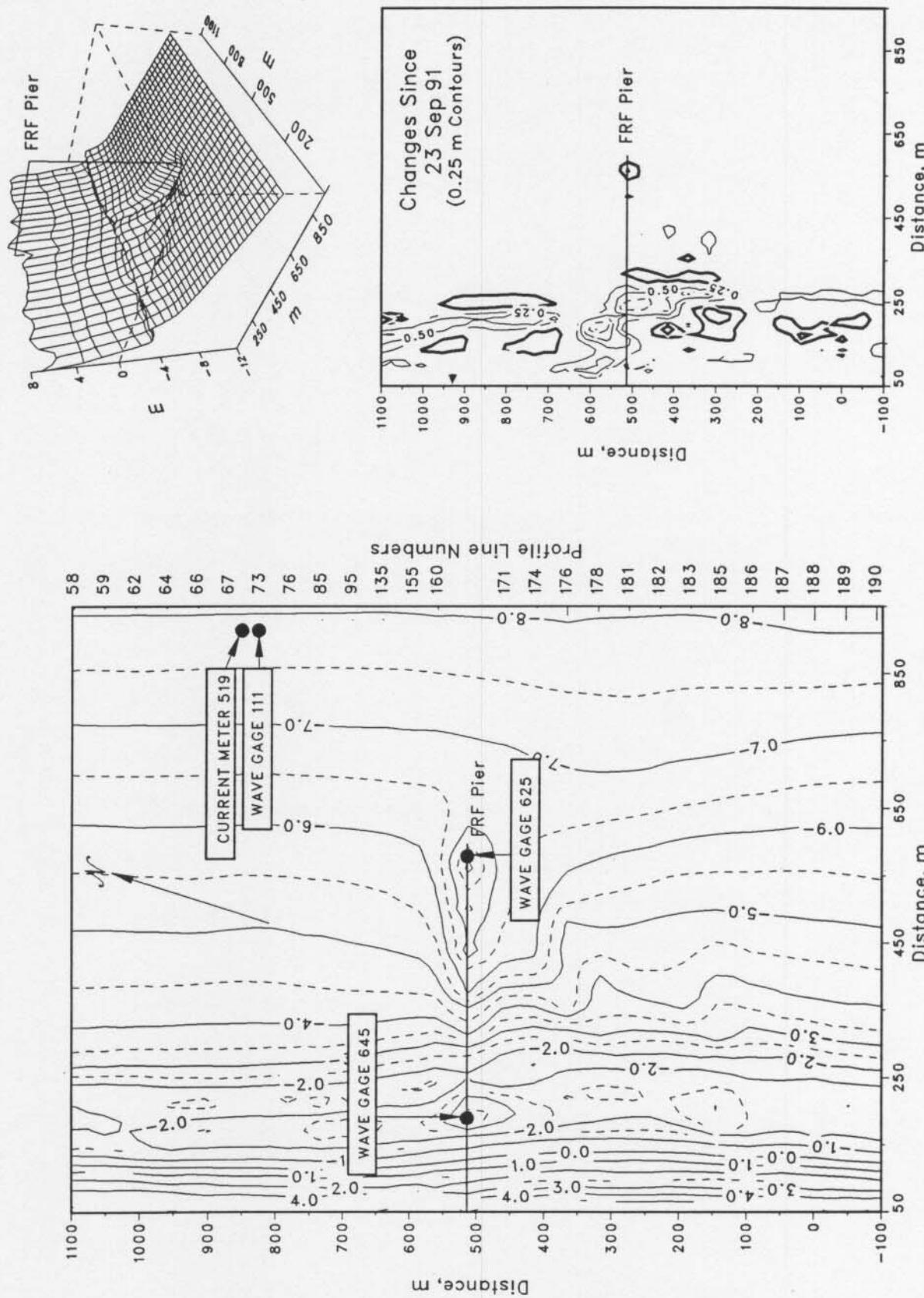


Figure 7. FRF bathymetry 23 Oct 91 depths relative to NGVD

## PART VIII. SPECIAL EVENTS

A. Storm Data Collection. The following list identifies times when the significant wave height at the seaward end of the pier (i.e. as measured at the end of the pier) exceeded 2 m and four contiguous 34 minute wave records were obtained every three hours:

<u>Start</u>	<u>End</u>
3 Oct (0808)	3 Oct (1142)
16 Oct (1408)	17 Oct (0542)
28 Oct (0434)	1 Nov (0842)

### B. Storm Synopsis.

3 October - Developing over southern Florida early on 1 October this small coastal storm slowly moved up the eastern coast being located off Cape Hatteras, NC on the morning of 3 October. Rapidly picking up speed the storm was located off the Maine coast early the next day. The maximum  $H_{mo}$  (at gage 625) of 2.34 m ( $T_p = 5.69$  sec) occurred at 0916 EST on 3 October.

16-17 October - Forming over Texas on 14 October this storm slowly travelled across the southeastern U.S. moving into the Atlantic on 16 October. Located off South Carolina the storm rapidly intensified beginning a northerly track up the coast. By 18 October the storm was located off the Maine coast. Peak onshore winds exceeding 15 m/s (from northeast) were recorded at 2308 EST on 16 October with the maximum  $H_{mo}$  (at gage 625) of 2.63 m ( $T_p = 7.31$  sec) occurring several minutes later at 2342 EST. The minimum atmospheric pressure of 1004.7 mb occurred on 17 October at 0434 EST. Total precipitation was 56 mm.

28 October - 1 November ("Halloween Storm") - This major storm which was similar in many respects to the 1962 "Ash Wednesday" storm was actually a sequence of events which began with a hurricane. Early on 27 October, Hurricane Grace approached the southeastern U.S. coast. While still well out to sea, Grace curved to the north following a track which paralleled the coast but kept her well offshore. By the morning of 28 October Grace was located approximately 1000 kilometers east of the North Carolina coast where she encountered a strong easterly moving Canadian high pressure system. The collision of these two systems produced high onshore winds at the FRF. Augmented by these strong winds, large waves, which were produced well offshore by Hurricane Grace, continued to build as they approached the North Carolina coast; wave heights recorded at the FRF increased throughout the day. Grace continued to track north finally being absorbed by a low pressure system located off Nova Scotia late on 29 October. The merging of these two systems produced a huge storm which, contrary to normal storm tracks, proceeded to slowly move to the southwest. Early on 30 October the storm was off the New England coast and generating hurricane force winds with a central atmospheric pressure of 988 mb as it continued its slow southwesterly course. By the morning of 31 October the

storm was located well off the Maryland shore; although still strong it had begun to weaken with its southwesterly movement greatly reduced. November 1 found the storm reversing its course and moving back out to sea as it continued to weaken. By the morning of November 2 the storm had curved back to the north however, by the time the storm crossed the Maine coast it had weakened considerably.

Although only a few ocean front structures on the Outer Banks were completely destroyed there was heavy damage to the primary dune system as well as extensive flooding and ocean overwash. Much of the sediment removed from the dunes was deposited inland burying most of an ocean front road while the flooding made many other roads impassable for over a week. Much heavier damage was reported to areas north of the Outer Banks especially along the New England coast.

Maximum wind speeds at the FRF approached 18 m/s at 1600 EST on 28 October while the maximum  $H_{mo}$  (at gage 630) of 5.93 m ( $T_p = 19.69$  sec) occurred at 0016 EST on 31 October. The minimum atmospheric pressure at the FRF only fell to 1004.7 mb, this was a result of the storm center remaining well offshore. There was no precipitation at the FRF from this storm.

This storm encompassed several interesting features. Waves with an  $H_{mo}$  above 2.0 meters (at gage 625) lasted for 101 consecutive hours. The maximum  $T_p$  reached 21.33 seconds on 30 October while waves with  $T_p$  above 15 seconds (normally only associated with hurricanes) were recorded both on 30 and 31 October, long after Hurricane Grace had passed. The storm surge at the FRF approached 0.7 m with the highest tide level reaching +1.53 m (NGVD) on 31 October.

Figure 8 includes a two- and three-dimensional contour map and a change plot derived from the bathymetric survey on 3 November following the storm. Wide contour lines on the change diagram represent eroded areas; thin lines indicate deposition.

Plots of data collected at selected gages during the storm are included in Figure 9.

Figure 10 contains pre and post storm surveys of four profile lines extending 900 to 1,000 m from shore and located 489 and 581 m north (profiles 188 and 190) and 517 and 608 m south (profiles 58 and 62) of the FRF pier. The profile changes were unusual considering the severity and duration of the storm. Although the nearshore bar moved offshore, the migration distance was less than expected. Even more interesting was the overall deepening of the profile seaward of 500 m. This is the first occurrence of storm induced lowering of the outer profile in 10 years of surveying. During a typical severe northeaster, the bar would move into this zone and the seaward most portion of the profile would experience either stability or a few cm of deposition.

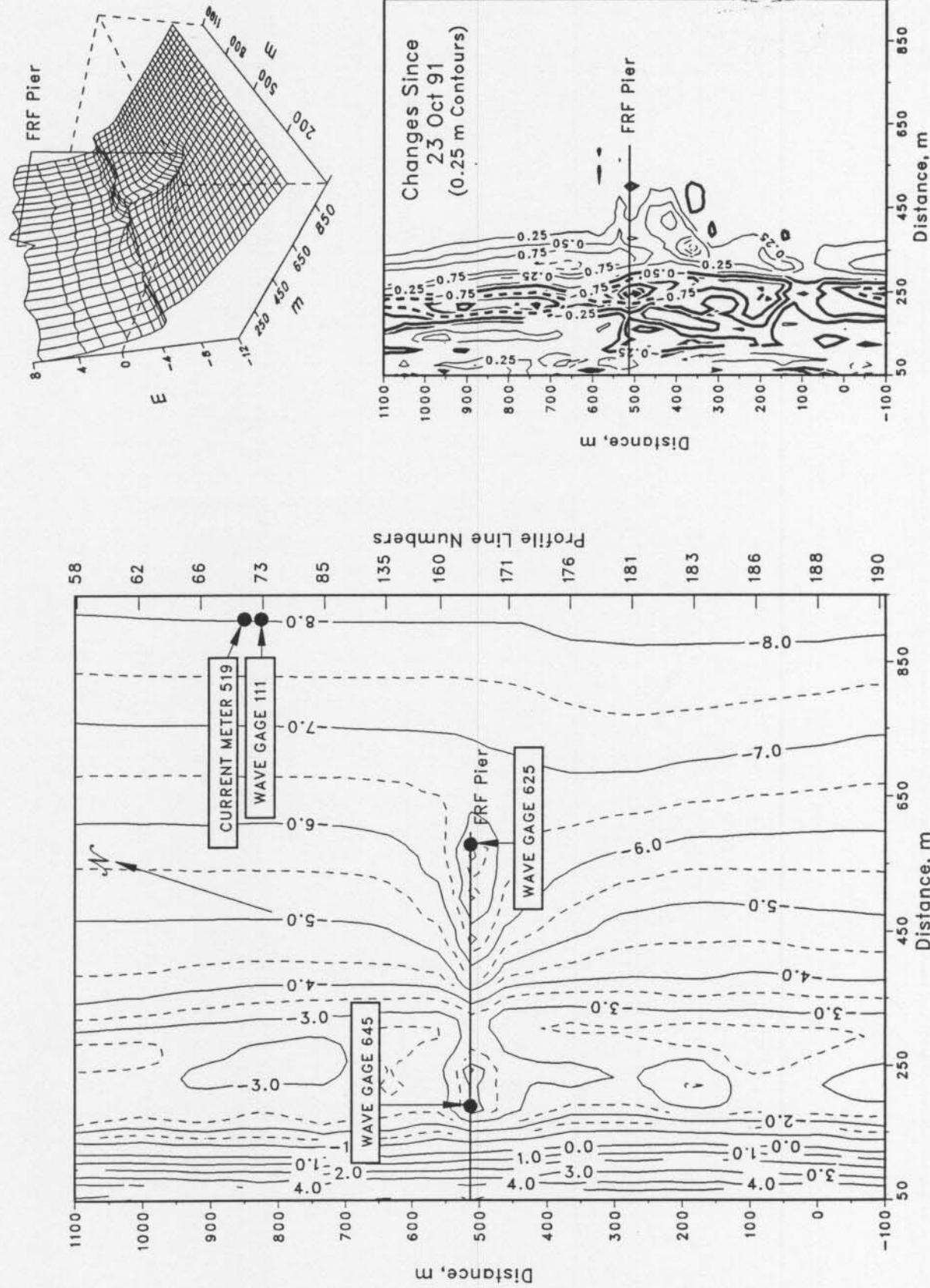


Figure 8. FRF bathymetry 3 Nov 91 depths relative to NGVD

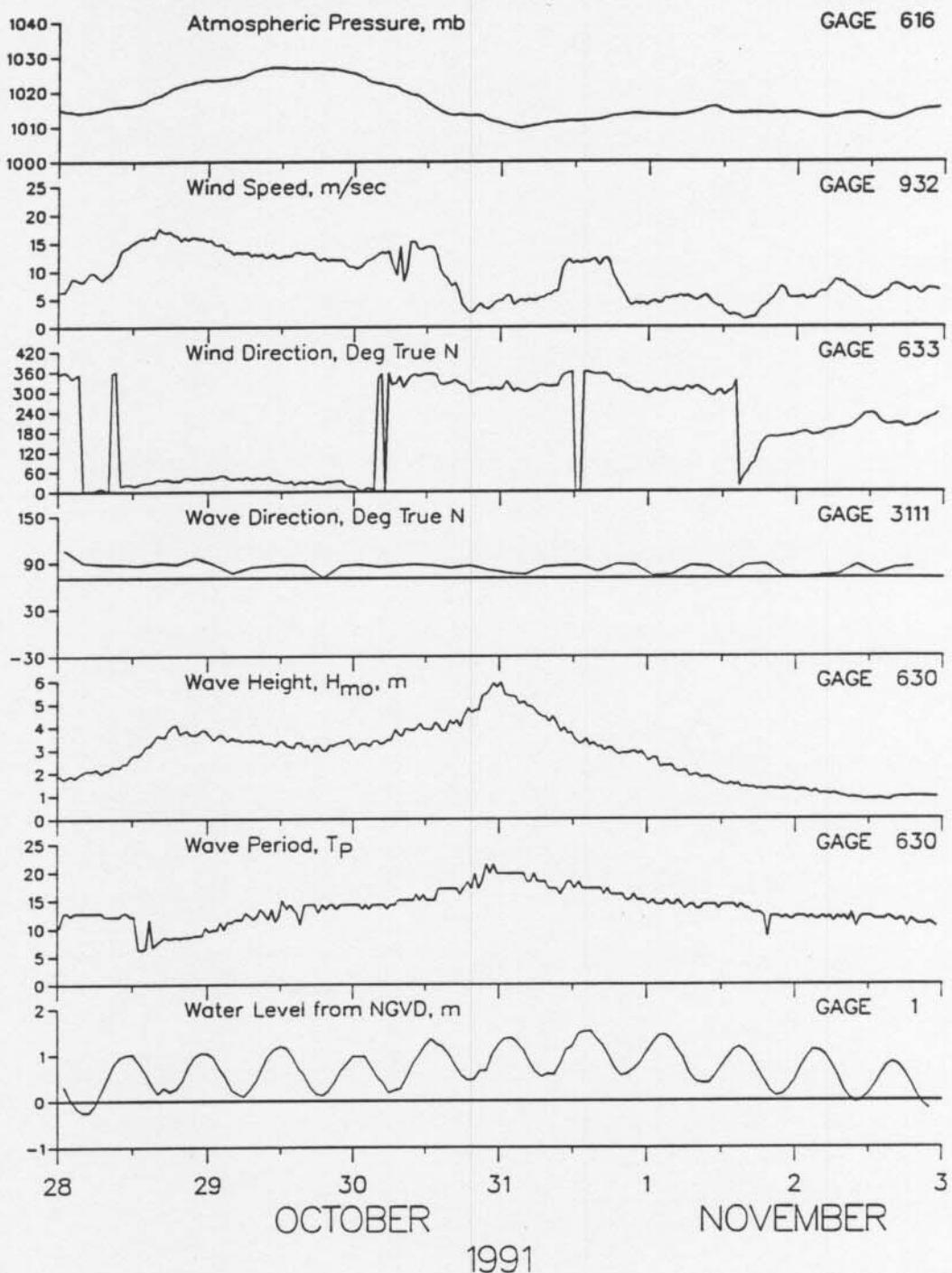


Figure 9. Data from selected gages during Halloween storm

NEARSHORE SURVEY, DUCK, NC

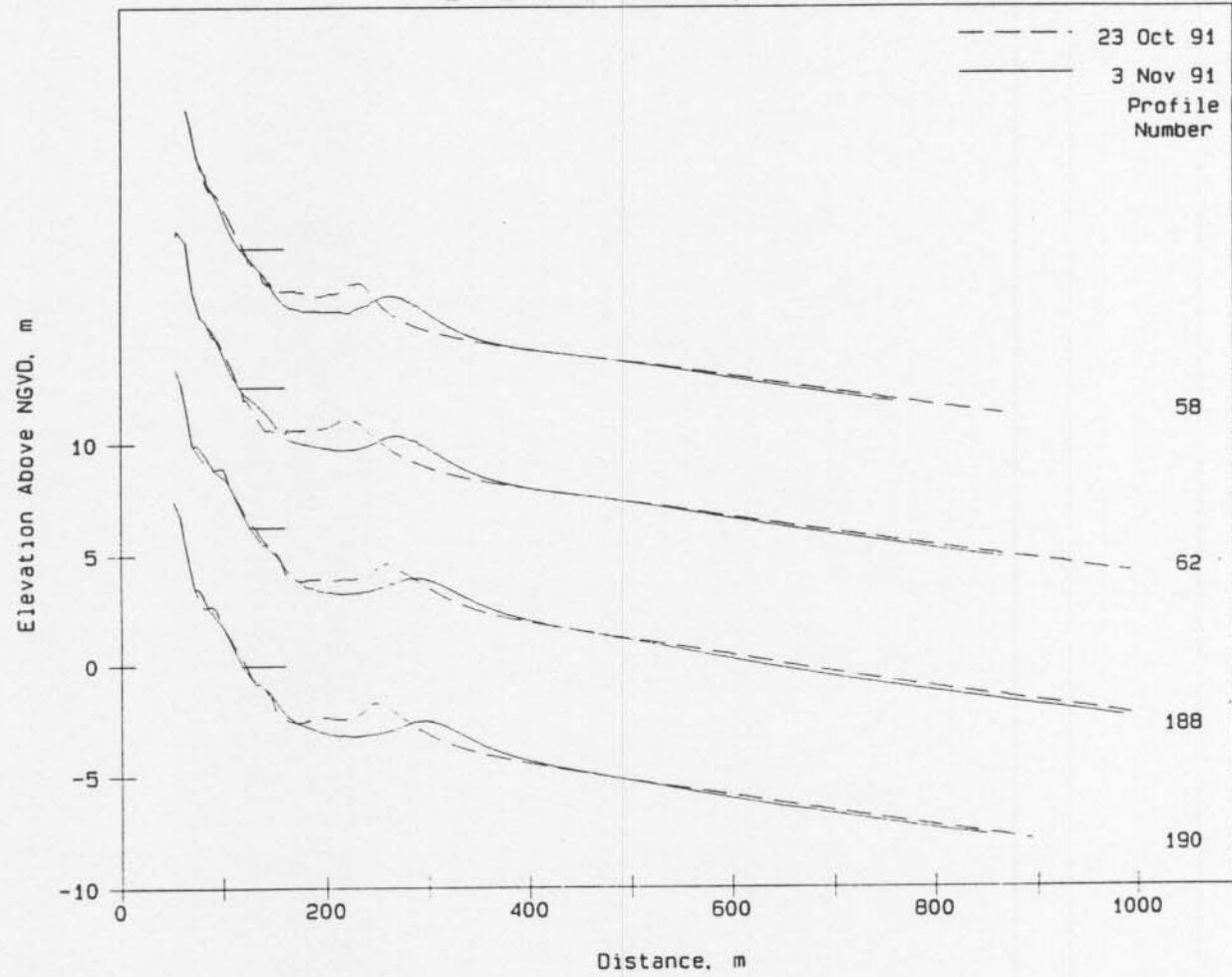


Figure 10. Halloween storm CRAB profiles

### Distribution List

#### Government Agencies:

OCE	U.S. Geological Survey
BERH	U.S. National Park Service
NAO	U.S. Naval Academy
NASA/Wallops Flight Center	U.S. Naval Civil Eng. Lab
NOAA (NOS, NWS)	U.S. Naval Fac. Eng. Com.
SAD	U.S. Naval Oceanographic Off.
SAW	U.S. Naval Research Lab

#### Colleges/Universities:

California Inst. of Tech.	Stockton State College
East Carolina University	University of Akron
Florida Inst. of Tech.	University of Delaware
Harvard University	University of Florida
Naval Post Graduate School	University of Maryland
NC State University	University of Miami
Old Dominion University	University of North Carolina
Oregon State University	University of N. Colorado
Prince George's College	University of Rhode Island
Rutgers University	University of Virginia
Scripps Inst. of Oceanography	Va. Inst. of Marine Science
Southern Illinois University	

#### Others:

City of Va. Beach, VA	MEC Systems Corporation
Coastal Barge Corporation	Moffatt & Nichol, Eng.
Coastal and Est. Res., Inc.	Offshore Coastal Technologies
Coastal Science & Eng., Inc.	Mr. Rowland
Dr. Galvin	Mr. Savage
GEOMET Tech., Inc.	Sea Port Supply Corp.
Greenhorne & O'Mara, Inc.	Shell Development
Dr. Hylton	Sherwood Industries
Mary Marr, Inc.	Mr. & Mrs. Valpey
Mr. Mason	WCTI-TV
Masonite Corporation	SEASUN Power Systems

#### Foreign:

W. F. Baird & Asso. Coastal Engineers, Ltd (Canada)  
Queen's University, Ontario (Canada)  
Ministry of Construction, Coastal Division (Japan)  
Norwegian Hydrodynamic Laboratories (Norway)  
University of New South Wales (Australia)  
University of Sydney (Australia)